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The present status of certain Aud.-vis. aids in
the biology classrooms ....

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Thesis

THE PRESENT STATUS OF CERTAIN AUDIO-VISUAL AIDS IN THE BIOLOGY CLASSROOMS OF THE PUBLIC SENIOR HIGH SCHOOLS IN THE STATE OF MASSACHUSETTS

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CHAPTER I

INTRODUCTION

A. Statement of the Problem

The objective of this thesis is to survey the present status of certain audio-visual aids in the biology classrooms of the public senior high schools in Massachusetts. To what extent are these classrooms equipped with these audio-visual aids and what use is being made of some of these aids? This is the question to be answered by this study.

It is the hope of the writer that the answer to this question will contribute to the improvement of the curriculum of biology in senior high schools.

B. Meaning of Audio-Visual Aid

Before an attempt is made to define the term "audio-visual," it would be well to discuss the development of the term. McKown and Roberts[1] state that the earlier used expression "visual education" has been largely replaced by the term "visual instruction," but even though this is widely used at the present time, it too has serious limitations. Nearly all forms of dramatizations, for instance, bring both a visual and an auditory experience, as does

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[1] Harry C. McKown and Alvin B. Roberts, Audio-Visual Aids to Instruction, p.6. New York: McGraw-Hill Book Co. 1942

also the sound film, description of an object, and explanation of a map. The sound film has broadened the original narrower conception of visual education.

Further, touch, taste, and smell can also be classified as channels for instructional aids. On this point Davis[2] says: "It is usually best to use many avenues of approach in learning. In some cases, it is desirable to experience the situation by simultaneous stimulation of many sense avenues." Touch in certain kinds of shopwork, taste in cooking, smell in chemistry are more important in these cases than visual or auditory experiences. Perhaps the term "multi-sensory" used to mean employment of all sensory experiences, as the Eighteenth Yearbook of the National Council of Teachers of Mathematics[3] suggests might be more accurate than any of the other expressions used.

However, the average learner in biology uses touch, taste, and smell infrequently and hence these senses represent a relatively small part of the sensory experience in learning. An individual obtains in the biology classroom the greater part of his experience through his eyes, a

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[2] Robert A. Davis, <u>Psychology of Learning</u>, p.357. New York: McGraw-Hill Book Co. 1935

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[3] <u>Multi-Sensory Aids in the Teaching of Mathematics</u>, Eighteenth Yearbook of the National Council of Teachers of Mathematics, p.1, Bureau of Publications, Teachers College, Columbia University, New York 1945.

lesser part through his ears and even less through his other senses. Although the last are not to be ignored, on the basis of the number and applicability of experiences, the writer of this study feels that the term "audio-visual" is the most appropriate expression. For a biological approach to this study, "visual aids" is too limited in scope and "multi-sensory" is too inclusive, as explained above.

Perhaps from the above discussion a definition of audio-visual aid is apparent. Dent[4] aptly defines this by saying: "Audio-visual is a term used to encompass visual aids, sound aids, and the various combinations of the two."

C. Value of Audio-Visual Aids

Many pupils learn words without comprehending their meaning. This is verbalism and is usually the result of insufficient experience with the subject at hand. It is the duty of the teacher to provide concrete teaching materials in the form of audio-visual aids as the basis of experience out of which understandings and insights may develop. Through an integration of concrete experiences generalizations develop. This is an important objective of teaching.

The importance of generalizations in teaching has been expressed by the committee on science of the National

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[4] Ellsworth C. Dent, Audio-Visual Handbook, p.2. Chicago: The Society for Visual Education, 1939.

Society of the Study of Education in 1932 in its Thirty-first Yearbook.[5] In it, it is stated that the major objective of education is life enrichment which may be accomplished by developing an understanding of principles or generalizations.

Allen[6] expresses the importance and value of audio-visual aids very well when he states that people learn much faster with the use of audio-visual aids, that the learner retains much more information by this method, and that audio-visual aids captivate interest and stimulate mental activity.

D. Principles Developed as Guides to the Successful Use of Audio-Visual Aids

The following principles set forth underlie the successful use of audio-visual aids.

Audio-visual aids should be carefully selected. Just as care is necessary in selecting textbooks, so is it necessary in selecting the proper kinds of audio-visual aids. This selection may be done by any teacher experienced in the use of these aids. Administrators, on the

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[5] _A Program for Teaching Science_, Thirty-First Yearbook of the National Society for the Study of Education, part 1, Bloomington, Illinois: Public School Publishing Co. 1932

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[6] C. Howard Allen, Jr., "New Routes to the Mind", _Voice of Reserve_ (March, 1947), p.14.

basis of their training, are more or less competent to give counsel.

The teacher should know the specific use of each aid and how to use it effectively. Each aid has its own particular function and because of this it can be used more advantageously in one setting than in another. A knowledge, therefore, of the particular use of each aid is necessary in order to get the most out of it.

The aid should be appropriate to the age and experience levels of the pupils. An aid will fail in its purpose if it is not suitable to the abilities, needs, and interests of the pupils. If it is beyond the experience and the comprehension of the pupil, learning will be impeded; if it offers too inadequate a stimulus because of utter simplicity, it will cause unfavorable pupil attitudes.

Audio-visual aids should not be confused with entertainment. An audio-visual aid is not meant to be a device of diversion but a means of motivation.

The use of too many aids at one time will cause confusion instead of clarification. It is a known fact that one pertinent illustration is worth a dozen scattered or unrelated ones, which will tend to divert attention rather than focus it on the subject at hand.

Aids should be located conveniently and circulated efficiently. If the teacher does not have the aid when he needs it, or receives it when he does not need it,

adjustment in the lesson plan will have to be made and this usually results in confusion and a situation unfavorable to effective learning.

Finally, visual aids are supplements to learning and are not meant to be substitutes for the oral and written methods for gaining knowledge. They demand greater skill from the instructor who must devote time and energy in selecting the appropriate and most effective aid.

E. Classification of Audio-Visual Aids

Hoban, Hoban and Zisman[7] have classified visual aids into five main groups: "The school journey; museum material, motion pictures, still pictures, and graphic material."

For purposes of this study, the present writer has further divided these groups as may be seen in the questionnaire in the appendix.

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[7] Charles F. Hoban, Charles F. Hoban, Jr., Samuel B. Zisman, Visualizing the Curriculum, p.9, New York: The Gordon Company, 1937.

CHAPTER II

CERTAIN AUDIO-VISUAL AIDS AVAILABLE TO THE BIOLOGY CLASSROOMS AS REVEALED BY THE LITERATURE

A. Previous Studies in the Field

Many articles have been written on what is being done on audio-visual aids in the classrooms of certain schools. There have been studies made, for example, on the use of the micro-projector and how valuable field trips are in teaching biology. A search of the literature revealed no study on the status of audio-visual aids in the biology classrooms of the public senior high schools in Massachusetts. The writer, therefore, felt the need for making an investigation of this problem, particularly because as a prospective teacher in biology he realized the necessity to collate and to present in systematized form for his own use and for others certain audio-visual presentations in the biology classroom and to offer possible suggestions for further studies that may be made.

The literature examined did reveal one study by Chapman[8] which may be worthy of mention. This study investigated the status of visual aids in the secondary schools of Massachusetts. The author used the five group classification of visual aids as expressed by Hoban, Hoban,

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[8] Leland Hildreth Chapman, The Present Status of Visual Aids in the Secondary Schools of Massachusetts. Unpublished Master's Thesis, Boston University, 1938.

and Zisman,[9] namely, the school journey, museum material, motion pictures, still pictures, and graphic material. He incorporated the status of visual aids in biology with those aids of other sciences under the heading of "Science Studies." Inasmuch as this thesis is dealing with the status of certain audio-visual aids in the biology classrooms of the public senior high schools in Massachusetts, the writer feels that Chapman's study does not adequately approach complete coverage of his problem. However, it is interesting to note what Chapman says with respect to science:

> The science department in the schools are large users of visual aids. Each aid is used to a large degree with the exception of exhibits from museum and stereographs. Almost three-fifths of the schools use silent motion pictures in this department. In regard to all of these aids the larger schools use appreciably more than the smaller schools.

In the pages that follow the writer will attempt to show certain audio-visual aids available for the teaching of biology as revealed by the literature.

B. Blackboard Equipment

Blackboards

Blackboards are an important aid in the teaching of science. They are very serviceable in the teaching of biology. Cellular structure of the blood tissues, principle

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[9] Opp. cit. p.9

of osmosis, process of digestion and assimilation, to mention a few, are biological concepts that can very well be presented on the blackboard and may be particularly elucidating when shown thus, step by step, even though there may be diagrams in the text. The blackboard, in this instance, is a good example of one visual aid supplementing another, namely text illustration.

The type of blackboard should be such that the board and crayon represent a sharp contrast in color. Movable blackboards are being increasingly used which enable all pupils to see the written material.

Colored Chalk

This aid is an indispensable part of the biology classroom. A picture in color has a greater appeal than one in white. All sketches, diagrams, and illustrations in biology may be particularly effectively shown by means of colored chalk. Different anatomical structures of plants and animals are well represented by this means. For example, the arteries and veins may be shown in red and blue respectively for a more ready and vivid presentation of the circulatory system in animals.

C. Still Pictorial Materials

Bulletin Boards

The bulletin board is handy for many subjects and especially biology. Every biology classroom should have a permanent bulletin board to display charts, posters,

diagrams, clippings and cutouts from newspapers and magazines. Members of the class should be encouraged to bring in and construct material for the bulletin board and in this way we can couple active participation with visual aid to encourage interest and receptivity.

In some classrooms the teacher has allowed the bulletin board to become overcrowded, unattractive, and filled with outdated material. Care should be taken to see that the material used is of immediate and direct applicability to the work at hand. The principles of display such as identifying with a title, labels, and notations stimulate the learning process of the pupils.

In connection with biology, all types of botanical and zoological pictures and diagrams may be displayed on the bulletin boards. Clipping from magazines supplied by commercial companies emphasizing good health habits may be used for a bulletin board display in connection with work in hygiene and sanitation.

Maps

Maps are visual aids which may be used in the biology classroom. They help the student to visualize and locate important world realities that he could never understand from written or oral material. For biology the map may be used to illustrate the habitat of plants and animals, and diseases endemic to an area of the world. Pupils may be asked to construct maps and the best ones may be tacked on

the bulletin board.

Graphs

Graphs represent statistical data by means of a picture. They aid the learner by presenting this data clearly and interestingly. A good graph requires very little explanation because fundamentally it is simple.

The bar graph is the simplest type of graph. It is usually characterized by the use of parallel bars which represent a series of connected facts. Its use is extensive in the field of hygiene and sanitation. Percentages of diseases for a given area and time may be depicted by means of a bar graph.

The pie chart represents percentage or fractional values of a whole. Its visual aid lies in its simplicity and unity. It is best shown by shading in the pie cuts. One example of this use might be in the field of nutrition where a type of food may be shown giving its percentage of fats, carbohydrates, and proteins.

Area graphs may be used in the field of biology to show comparisons of amount differences. The amount of certain botanical and zoological material may be compared with the amount of the same type of material in another area. The most common figures for graphic representation of this kind are circles, rectangles, squares, and triangles.

The picture graph is used to show quantities by means of pictorial symbols. The picture used is a likeness of the

things which it represents. The picture graph tends to animate statistics and to make statistical data concrete and interesting. The picture graph is of importance in the field of parasitology, for example, where a symbol of a parasite may be used to indicate the numbers of parasites and whether they have increased or decreased during a certain period.

Photography

There are two approaches in the use of photography and each shares in making the presentation effective and interesting. The student may use his own camera in photographing his observations. The apparatus used may be simple, a pin hole camera made by the pupil himself or an inexpensive commercial camera that will take as many as sixteen exposures on a roll of film that can be purchased for about twenty-seven cents. The biological student may use his camera for "before and after" experiments, for day to day growth and progress recording, for pictures of things seen on field trips. Photographs may be taken of botanical gardens, aboretums, zoological parks, and museums, for further reference and study. Further, now that color film has come into its own, this very important media is also available to the instructor for a certainly effective approach to a subject by means of audio-visual aid.

And, again, there are the photographs of others collected and accumulated from such sources as Nature, Science, National Geographic, and other magazines, travel agencies, museums, and newspapers, especially the "Christian Science Monitor." Whenever teacher and pupil cannot share direct contact with subject material, they may obtain much photographic material from the sources mentioned and also from commercial concerns which frequently publish photographic brochures on their processes. For example, many milk companies furnish profusely illustrated booklets of the Pasteurization process.

Diagrams and Posters

The diagram is a visual explanation of relationship and arrangement. It is the most abstract of visual aids and may be used to illustrate comparative values, origin and development, chronological sequences, as for example, a diagram of the circulatory or digestive system. Certain scientific laws such as Mendel's hereditary principles, may be illustrated by the diagram.

The poster is another important visual aid that is much used in biology. It is a means of vividly presenting in colorful and illustrated pictorial form ideas, facts, and principles that may be the more easily understood and assimilated than through a text or audio presentation. For example, graphic posters illustrating in full color the

foods that constitute the seven basic ones cannot but make a sharp impression on even the student who reads as he runs. Posters are very frequently used in the personal hygiene phase of biology, particularly depicting care of the skin, the teeth, and other Personal habits. Posters can be even more technical than the more familiar type mentioned above, like those showing the different chemicals of the blood and protoplasm. This done in many colors and in bold, clear cut type gets the message across frequently better than the text does. Or, the poster may be used in conjunction with text and lecture material, as is most often the case.

Cartoons

The cartoon is a visual aid emphasizing a fact by means of humor or satire. During the past few years excellent cartoons on insect control, health and conservation have been developed. The cartoon is effective in bringing out a point that is difficult to explain, or it helps to lighten a load that may be dull. Many laws and theories, Mendel's Laws of Heredity again, for example, can be epitomized with a cartoon.

Photos of Biologists

Photos of biologists placed about the classroom and brought to the attention of pupils will aid in bringing about an understanding of the development and growth of biology. They also serve to stimulate interest in learning

and understanding the achievements of biologists.

Wall Charts

According to Perry[10]:

> Charts have at least three well-defined uses. First, they may supplement, even take the place of the text, and in this way be a direct means of giving new information. Second, they are valuable in staging review. Third, their construction frequently provides an excellent type of pupil activity.

Wall charts are extensively used in biology. Wall charts include the classification chart which shows sequence and interrelation of parts. The classification chart has one form which has special value in showing growth and development. This is the genealogical table, expressed in two ways: the tree form or the stream type form. Theories of evolution, for example, may be best illustrated by this form of chart.

The chart is most meaningful when it comes after the pupil has had an opportunity to obtain some concrete experience with the subject. After a field trip is made investigating plant and animal life, the wall chart may be used effectively when discussing these plants and animals.

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[10] Winifred Perry, "Visual Aids for General Science Classes, Science Education 23 (Oct. 1939), p. 247.

The value of wall charts in teaching certain topics of biology was shown in a study made by Bergman[11] who found that when the material was presented with the help of charts, it was better retained than without the help of charts. The topics studied were: 1. external anatomy of the lobster; 2. internal anatomy of the lobster; 3. external and internal anatomy of the grasshopper and 4. internal anatomy of the frog.

Wall charts may be obtained commercially covering practically every phase of biology. Pupils should be encouraged to collect pictures and to mount them on a chart. Pictures on health, hygiene, insect, plant, and sea life may be collected and charts made from them.

D. Classroom Equipment

Filing Cabinets

Steel filing cabinets are valuable in preserving and storaging pictorial materials such as diagrams, posters, charts, cartoons and graphs. Any projected program of audio-visual aids endeavoring to be comprehensive would fall short if adequate space were not provided; and filing cabinets are eminently satisfactory. Otherwise, many of the exhibits would be lost or damaged.

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[11] George J. Bergman, "Effectiveness of Charts in the Teaching of Certain Units in Biology," Science Education 24 (Feb. 1940) pp. 103-111.

The pictorial materials must be indexed for ready accessibility and this can well be done by the pupils who will acquire familiarity with the materials in doing so. Classification should be the teacher's job and she should decide the method of filing, that is whether by type of material (diagram, poster, charts) or under the different biological topics (circulation, respiration, hygiene and the like). If the former is used an effort should be made to classify the type of material according to biological topics within the type itself.

The cabinets must not be allowed to be filled with useless material. A check should be made at certain times for the purpose of removing obsolete and useless material.

Exhibit Cases and Shelves

Exhibit cases and shelves are used to display and to store models either obtained commercially or constructed by the pupils. Biological models such as the heart, ear, and the eye when placed in the laboratory will arouse student interest and thus may well stimulate the learning activity. Located in the corridor, they will give visitors and parents an idea of what is being done in the biology classes. The glass case is extensively used for displaying models. It gives protection to the materials being displayed.

Demonstration Desk for the Teacher

Effective teaching in biology requires the classroom to include a demonstration desk. By means of the demon-

stration desk the teacher performs experiments to guide and stimulate the pupils in the use of the laboratory. When the teacher conducts the experiment and at the same time questions the pupils, an attempt is made to encourage the pupils in the subject.

An adequate demonstration desk should include a source of water, gas, and electricity. There should be drawers and cabinets for keeping materials and equipment. Placing the desk on a platform about six inches higher than the classroom floor is desirable for adequate visibility from every part of the classroom.

Models of the Human Anatomy

Probably the next best thing to the real thing is the model. It gives a correct representation of the object and enables the pupils to learn the interrelationship of the various parts.

Models of the human brain, heart, eye, ear, and torso may be obtained commercially or constructed by the pupils. They should be life-size, naturally colored, and dissectible showing the parts of the anatomy and their relationship. The study of digestion and respiration take on new interest and become fascinating subjects when a dissectible model of a human torso is available.

Bookcases with Biology Books for Use Other Than Regular Text

Pupils may do reading in biology courses on a required or voluntary basis. This reading may be divided into

collateral and supplementary.

A further understanding of a topic in biology may be gained by collateral reading. Some pupils may read to satisfy their desire for additional information. For this reason, the biology classroom should be equipped with different texts covering the work of the course.

Supplementary reading consists of recreational reading, reading on the history and the development of biology and any other readings not directly related to the topic being studied. This reading is desirable in that it can arouse an interest in biology in a number of pupils. Therefore, the biology classroom should include appropriate magazines, books, and pamphlets.

Human Skeleton

To comprehend the fundamentals of the human anatomy, the skeleton is an indispensable aid. By seeing the relationships of the various fundamental components of the human form, the pupil acquires a more vivid picture of the living human body.

E. Laboratory Equipment

Laboratory Manual

The laboratory manual serves as a guide to the students while doing laboratory work. It helps to focus attention on the important points of the laboratory work. Many of the newer manuals are supplying many of the specimen drawings in outline form so that the pupils need only to label

them.

It has been the fault of many pupils and teachers to follow the laboratory manual as if it were a book of recipes. Probably no manual fits completely a local teaching situation, unless it is based upon a study of that situation, and even then it usually is not adapted well enough to the needs of the pupils to warrant following it religiously. The laboratory manual should be looked upon as a teaching aid which will facilitate the pupil's learning.

No discussion of manuals would be complete without some consideration given to the matter of the notebook. The notebook is used in order to hold the pupils responsible for laboratory work. It should include drawings and notes. Simple, properly labeled, outline drawings should be encouraged. Notes, not simply the usual notes describing drawings but clearly written accounts of observations, experiments, and conclusions are best.

Mounted Specimens

Mounted specimens serve to kindle interest and help to give an understanding of the biology work. They have a real use for the purpose of review. In this respect, the identification test is a common exercise. Mounted specimens may be numbered and the class asked to name them. One advantage of having mounted specimens is that they are permanent and so are relatively inexpensive.

Insect and bird collections, and dry and wet mounts of invertebrates are the commonest types of mounted specimens. Pupils may collect their own specimens and mount them in boxes.

Plastic Material and Wood for Modeling

Many of the models not available commercially may be made by biology students. The techniques involved are relatively simple and can be carried out by an average group of students. The common materials used in modeling are: plaster of Paris, modeling clay, papier mache, wood, and soap. In connection with these materials Mandl[12] says:

> Plaster of Paris: A cheap material in model making. Should be mixed only when ready to use for it hardens quickly. Plaster of Paris may be poured into a tray which has been first covered with a fine film of oil. This prevents it from sticking. Plaster of Paris should be stirred into a small quantity of water until it reaches the consistency of thick cream. This may be used like modeling clay, that is, may be molded into place, or it may be poured into a mold for carving later.
>
> Modeling clay: In making modeling clay projects it is desirable to place the model on a varnished board or some object which will not show the oil stain caused by the clay. Modeling clay has its advantages as well as its disadvantages. It is very pliable, and so changes may be easily made. However, it is very soft and requires great care in handling. When working with modeling clay various home tools may be constructed. An orange stick is desirable and bristles of a brush may be used as cilia. The entire model may be colored with an oil paint.

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[12] M. M. Mandl, "Project Method in High School Biology," School Science and Mathematics, 31 (Dec. 1931) pp. 1089-1090.

Papier mache: This is made from old newspapers which are torn up into small pieces, soaked in water with the addition of a small amount of glue. The paper is then kneaded into a pulp which turns it into a creamy consistency. The material is light when completed and does not break. The pulp is treated like modeling clay.

Wood: Those pupils skillful with tools may be encouraged to make models of wood. A coping saw can be used to make patterns of intricate design, which may be glued together to form almost any kind of model desired. With some wood filler, and the proper addition of modeling clay or putty, some exceptional work may be secured.

Soap: A fresh piece of soap is desirable. Dried soap will not carve easily and will chip and break. Ivory soap is about our best soap for modeling. A paring knife is our best tool. If larger models are desired, several pieces of soap may be glued. Models may be carved in relief, so they stand out, or may be carved into the soap as to be indented. The completed model may be painted and covered with a thin coat of shellac. Models should be attached to a board for handling.

Aquarium, Terrarium, Herbarium, and Conservatory

The above named are visual aids which stimulate and direct the learning process of students.

With the aquarium most of the fundamental principles of biology may be demonstrated. It shows the dependence of animals directly or indirectly upon green plants for their oxygen and food supplies. Respiration, digestion, growth, and reproduction of both plants and animals, parasitism, saprophytism, and food cycles are but few of the principles evident from an aquarium.

One of the most useful aids about a biology classroom is the terrarium. The advantage of the terrarium is that humidity can be kept high so that many plants may grow successfully. The terrarium is useful for growing ferns, liverworts, and some mosses. It may be used for demonstrating typical plants of a swamp or desert area. It can also be used for caging small animals.

A collection of dried and preserved plants has an important role in any course in biology. When living specimens are not obtainable, dried or preserved forms are next in value as visual aids. The collection of such forms in a herbarium enables the teacher to exhibit groups of closely related species, genera, and families which are usually impossible to get together in a living state at the time they are needed.

The conservatory is a place where plants are grown and stored and as such affords the pupil an opportunity of observing the growing plant in its various stages. One advantage of the conservatory is that plants may be grown here in and out of season. A disadvantage of it is the cost which makes it prohibitive for the small school.

Dissecting Equipment

Various dissecting tools are needed as aids to learning in the biology classroom. These include dissecting needles, dissecting pan, scalpels, and a section razor.

Collecting Equipment

Collecting equipment for small animals include hand nets, bottles with stoppers or jars with lids, with or without poison. Traps are best for capturing larger animals.

Cages for Animals

Small cages which may be constructed are a necessity about the biology laboratory where living animals are studied. One which answers the purpose for many insects and other smaller animals may be made from pound-size coffee cans. An ordinary fruit jar with a Kerr screw-cap can be made into a very satisfactory cage for many purposes.

Slides

An object to be studied under the microscope is mounted on a glass slide. Some slides are permanent while others are prepared for immediate use. The latter are known as wet mounts.

The making of prepared slides consists of a complicated process, and so are usually obtained commercially. All types of prepared slides may be purchased. Blood smears, tissue slides and bacteriological slides are but a few that may be obtained commercially.

Wet mounts can be made to observe such things as the living cell and the motility or bacteria. In both cases the living material must be kept moist by some fluid medium, hence, the term "wet mount."

Microscope, Magnifier and Lamp

The microscope is used for studying prepared slides or wet mounts. It is, of course, desirable to have one for each student but if this is not feasible students may "double up" or the micro-projector may be used. Instruction in the use of the microscope must be given to the students prior to use so that an intelligent handling is effected.

The hand lens or magnifier is valuable in the observation of insects and other small animals. In botany it may be used to observe the various parts of plants not easily seen with the naked eye.

In order for the pupil to utilize fully the benefits which a microscope offers, optimum light must be available. There are many forms of illumination. Daylight may be used but this is a poor source of light because of the lack of a point source of illumination. For this reason, special microscope lamps are advisable.

F. Classroom Facilities

Space for Laboratory Use

Cole[13] expresses the following opinion in regard to the space for laboratory use:

> In general we may say that any biology laboratory should provide a convenient supply of electricity, water, and gas; make provisions for an easy storing of equipment, including microscopes; supply

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[13] William E. Cole, The Teaching of Biology, p. 106 New York: D. Appleton-Century Co. 1943

> facilities where both live and preserved plants and animals may be kept for observation; provide for unrestrained individual pupil activity and for displaying pupil projects and collections; furnish opportunity for some plant and animal experimentation; arrange for free pupil discussion, and because of the present emphasis on demonstration work in all sciences, including biology--a demonstration desk for use by pupils and teacher.

Electrical Outlets, Gas, and Water

Not much need be said with respect to electrical outlets than to say that biology classrooms should have adequate provision for the use of projection equipment. Outlets are necessary not only for the use of projectors but for the use of other equipment such as microscope lamps.

Gas and water are a necessary part of the biology classroom. Without them few, if any, experiments could be carried on. Water, also, serves its use as food for animals.

Motion Picture Screens, Stationary and Portable

Successful projection of pictures requires a suitable reflecting surface such as a screen. There are two types of screens: the stationary and the portable.

Since films are of most value to the pupils when shown in the classrooms, permanent screens would entail the expense of having them in every classroom in which films are shown. On the other hand, portable screens require more time to transport and set up.

In either type of screen two factors should be considered: the direct reflective power of the screen and the

largest angle to which the screen will reflect pictures satisfactorily.

Sink

At least one sink is necessary in each biology classroom. The purposes of the sink is to rinse instruments and to dispose of wastes from dissections and experiments.

General Storage Room

The presence of a general storage room for the biology department prevents the accumulation of materials infrequently used but nevertheless of importance. The storage room is also the place to keep excess materials.

Flat-Top Desks for Student Laboratory Use

It is desirable that the tops of laboratory desks should be alkali and solvent resistant. In biology, desks which accommodate two or four students are preferred to those accommodating more students. It is also desirable that desks be provided with locker and drawer space.

G. Projection Equipment

Micro-Projector

The micro-projector is one of the recent advances in the projection of visual-aid apparatus for the teaching of biology. It is an apparatus for showing microscopic specimens on the screen. Some such specimens include bacteria, protozoa, and algae. An advantage of the micro-projector is that it enables the teacher to point out the various things he wants the class to see. This is an impossibility in the

ordinary microscope study. Another advantage is that the micro-projector may well take the place of several expensive microscopes in the ordinary biology classroom.

In a study by Brechill[14] neither the individual microscope nor the micro-projector showed marked superiority as a teaching instrument in groups of any particular intelligence level. When the pupils were questioned as to which instrument they preferred, some said the microscope while a larger number favored the micro-projector. The author concluded:

> Best teaching might be done if a method were adopted which combined the use of the two instruments. Some skill in the manipulation of a microscope and appreciation of its use seems to be unquestionable assets for students.
>
> An acquaintance with the general appearance of a slide, gained by observation of the image thrown upon a screen by the micro-projector, would place a student in a better position to recognize and understand the material later, when he was given an opportunity to study it under a microscope.

Stereoscope and Stereograph

The stereoscope is an optical instrument used to make surfaces appear as solids and to give an impression of depth.

There are two kinds of stereoscopes used in the school today. These are the small stereoscope which pupils can

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[14] Edith Brechill, "A Study of the Micro-Projector as a Teaching Aid," Science Education 26 (April 1941) pp. 215-218.

hold in their hand to see the stereograph; and the telebinocular, a much larger and heavier instrument which is generally placed on a table for use and is electrically equipped.

The stereoscope has its uses in many studies. Because it produces the impression of the third dimension, it is used in physics, particularly in the field of mechanics; in mathematics, particularly in geometry; and in biology for microscopic examination of such objects as bacteria and protozoa.

The stereograph consists of two photographs of an object taken simultaneously by a stereoscopic camera, one which has two lenses, and when mounted and viewed through a stereoscope, binocular vision results.

The importance of the stereograph as a visual aid is expressed by Dorris[15]:

> Of all the static pictures available for school use, the stereograph is unquestionably the most valuable as a means of conveying vivid experiences and accurate mental concepts to the minds of young children. With the exception of the flat picture, it is the most valuable and the most convenient to use in the natural teaching situation.

Lantern Slides

When projected on a suitable screen, lantern slides

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[15] Anna V. Dorris, "Visual Instruction in the Public School", p. 135 Boston: Ginn and Co. 1928.

give a clear picture in which details are brought out distinctly. Excellent slides illustrating all phases of biology may be obtained commercially or made by teachers and pupils.

Teachers should become familiar with outfits furnished commercially to make lantern slides. Blank slides of ground glass, colored pencils, cellophane sheets, and bottles of various shades of transparent ink are included in these outfits. The ground glass slides on which diagrams and pictures are drawn may be cleaned and used repeatedly. Transparent inks or water colors may be used for coloring slides. These, too, may be washed off and the slides used again.

A statement of the value of lantern slides is found in "Visual Aids for General Science Classes":[16]

> Slides may be used for class discussion. Unlike the stereograph they are suited to group activity. They have an advantage over film strip and still film in that they may be shown in any desired order, and all slides in a set need not be shown unless they are needed. They are also valuable in opening new vistas and in arousing interest in a new unit or subject. Slides also provide excellent material for review.

Stereoptican or Lantern Slide Projector

In order to obtain a clear projected picture of the lantern slide, it is necessary to have a good lantern slide projector, one which meets a set of standards. Some of these

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[16] Op. cit. p. 247

standards as expressed by Hoban, Hoban, and Zisman[17] are:

1. It should be simple in construction.
2. It should be light but durable.
3. It should contain, above everything else, good lenses and reflector.
4. It should have a convenient slide carrier.
5. It should be easy to set up, to adjust, to operate, and to clean.

Opaque Projector

The opaque projector is used to show non-transparent material such as photographs, postcards, book illustrations, and drawings. These materials are reflected as images on a screen by means of mirrors in the projector.

The picture is usually inserted at the bottom of the projector and a spring is provided to hold the picture in place. It is so constructed that an entire book may also be inserted.

A valuable asset of the opaque projector is that the material used costs very little or nothing. Color can be shown naturally and realistically so that it is of value in the projection of such specimens as leaves and flowers whether they be mounted or appear as a colored picture.

Motion Picture Projector

Motion picture projectors are important. They are relatively expensive pieces of projection equipment and entail the added expense of having portable or permanent screens, and films. Besides their expense, portability is

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[17] Op. cit. pp. 166-167.

another factor which limits the use of this equipment in the classroom. Newer models, however, are made lighter than earlier ones with the result that they can be carried from one classroom to another.

Film Strips

The film strip is a roll of still pictures printed on motion picture film which may be projected on a screen. The film strip has several advantages over the glass lantern slide in that it is inexpensive, less bulky, and non-breakable. The film strip does not, however, give a good picture with distant shots or those requiring great detail.

Film strips may be obtained commercially covering all fields of science. Excellent film strips in biology covering health, physiology, and plant and animal life may be obtained in this way.

Sound and Silent Motion Pictures

There are several reasons why the motion picture is one of the best types of projected visual aid. With the motion picture camera, one can take pictures of any rapidly moving object, the speed of which makes it impossible to be studied by the unaided eye. The same device may be used to speed up action to a point where an object can be studied in but a few minutes, such as the life cycle of a plant. Similarly, it can be used to stop the action of a moving object at any time to allow the class to study it.

As well as its advantages the motion picture also has its limitations. It is a substitute for the actual experience. The school journey should be used to study life in its natural environment if it is possible. The motion picture should only be used in those situations where motion is necessary to give the right impression. A motion picture of an inanimate object is not as good as a good projected still picture, photograph, or model of an object.

H. Activities

Biology Club

The school club is becoming an increasingly important part of the educational curriculum. Such an activity was formerly spoken of as extra-curricular but today it is looked upon as an extra-class activity.

In large high schools, separate science clubs for each of the sciences may be advisable but in small high schools, a single science club made up of students from all the sciences is best.

The success of the science or biology club depends upon its organization and execution of its programs. All pupils enrolled in science courses should be encouraged to join and the club should have a faculty advisor, preferably one of the science teachers. It is important that the program be so diversified that an interest is developed within the student for the science. The program of the club may include experiments, displays of projects, field trips,

reports on science topics, lectures by men of science, social gatherings, and the like. The faculty advisor should allow the students to execute the programs.

By means of a biology club organized at the Julia Richman High School, New York, New York, the faculty advisor[18] was able to discover and encourage individual interests and aptitudes with gratifying results. She concluded:

> The biology club proved valuable for its vocational, avocational, and cultural contributions. It also encouraged the development of scientific attitudes and habits of thinking. Since these are the fundamental objectives of secondary education, I believe that the organization of a biology club is an effective device for individualized instruction and an aid in the preparation of our youth for efficient living.

Field Work and Trips

One of the most effective visual aids for the biology teacher is the field trip because it deals with real things in real situations. If pupils are studying water purification they may visit a nearby plant to observe the procedures used. In this way, the study of water purification does not become a long and difficult one but a concrete experience in which it becomes relatively simple.

Material collected on a field trip in biology may be used for further study. The better specimens collected may

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[18] Frieda Fichtman, "The Biology Club for Individualized Instruction," School Science and Mathematics 36 (Dec. 1936) p. 973.

be preserved and kept as a part of the permanent laboratory collection. No expensive equipment is necessary for any field trip. For the pupils to be taken on a tour of the world outside under the guidance of their biology teacher will make them aware of things as they are and will bring to life their text book and many interests that lay dormant.

A study by Stevenson[19] of pupil comments showed that when field trips were successfully conducted they were the most valuable, enjoyable, and worthwhile portions of the class work. The field work also brought the students in contact with more actual science and contributed most to teacher preparation. An article by Washton[20] mentions that 93 per cent of nearly twelve hundred students questioned felt that their study of biology would have been more interesting if outdoor classes had been held. Schellhammer[21] demonstrated by means of an experiment that field trips enlarge the pupils learning process to a measurable degree.

Planning and Working on Exhibits

The planning of an exhibit will prove entertaining and educational to the pupils. Teachers know that pupils are more

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[19] E. N. Stevenson, "Questionnaire Results on the Value and Extent of the Field Trip in General Biology," Science Education 24 (Sept. 1940) pp. 380-382.

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[20] N. S. Washton, "Findings in the Teaching of Biology," School Science and Mathematics 41 (Apr. 1941) pp. 553-558.

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[21] F. M. Schellhammer, "The Field Trip in Biology," School Science and Mathematics, 35 (March 1935) pp. 170-173.

interested in the concrete than in the abstract and that the oral or written word means very little unless there is some previous concrete experience with the object symbolized by the word.

The many and varied exhibits make possible the bringing together of the energies of pupils possessing different abilities and interests. Pupils may construct models which with posters explaining the model serve as fine exhibit material. Others may collect botanical and zoological specimens which may be dried, preserved, and mounted in boxes. These specimens can be made a part of a permanent collection.

The site of the exhibit will have to be chosen and equipment such as shelves, glass cases, and tables will have to be assembled and arranged. Each article in the exhibit should be so labelled that it is easily identified.

Dramatizations

Dramatization of biological principles and historical events are a neglected form of visual aid. The success of such motion pictures as "The Life of Louis Pasteur," "Madame Curie," and "Dr. Ehrlich's Magic Bullet" furnish good evidences that stories of scientific nature furnish acceptable themes for entertainment. Short plays based on the life of Florence Nightingale and Robert Koch have been successfully staged by high school pupils.

In making plans for using a dramatization, proper selection of a cast is necessary. Only the best students should be selected. It is advisable to have an alternate for each part in the play.

An example of a dramatization presented at Palmyra High School, Palmyra, New Jersey during an assembly period of the school year 1936-1937 is given by Heiss, Obourn and Hoffman:[22]

The advancement of medical science through the ages:

Part I.	Primitive Practices in Medicine Sketch: The Medicine Doctor as shown by the Indians
Part II.	The Transitional Period Tableau: Dining Scene in Ancient Castle Showing Unsanitary Conditions of the Time
Part III.	A New World is Discovered Play: Scenes from the Life of Pasteur
Part IV.	Modern Medicine Tableau: The Nurse (Florence Nightingale) and Doctor at Work

The program took forty-five minutes. Each teacher in the science department supervised one of the four parts, giving both direction and equipment to the students. The costumes were made by the students.

Biological Scrapbook

This scrapbook is composed of clippings of biological interest, pictures and news items taken from magazines and newspapers. It seems advisable that the scrapbook be one of

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[22] Elwood D. Heiss, Ellsworth S. Obourn, and C. Wesley Hoffman, Modern Methods and Materials for Teaching Science, pp. 222-223, New York: Macmillan Co. 1940

the optional activities of the biology students and that it be restricted to the acquisition of current material only.

CHAPTER III

CERTAIN AUDIO-VISUAL AIDS USED IN THE BIOLOGY CLASSROOMS OF THE PUBLIC SENIOR HIGH SCHOOLS OF MASSACHUSETTS

A. Method of Procedure and Sources of Data

Distribution of Check Lists

The questionnaire in the Appendix was mailed to every public senior high school in the State of Massachusetts. They were addressed to the heads of the biology departments. The number of questionnaires totaled 258. Of the 258 mailed, 143 or 55.4 per cent have been returned to date. In compiling the results all 143 returns have been used.

Geographical Distribution of Returns

The outline map on the following page shows the geographical distribution of the schools cooperating in this study. Although the schools were not asked to disclose their names on the questionnaire, an inspection of the post mark seems to be good evidence of their location. It may be seen that an overall distribution seems to be fairly representative in spite of a large clustering of dots about such large cities as Boston, Worcester, and Springfield. The cluster of dots about Boston represent many schools in the suburbs of Boston. There were 7 returns from the public senior high schools of Boston proper and these are shown by a single dot to the right of the cluster.

Validity of the Present Study

In discussing the validity of this study, we are con-

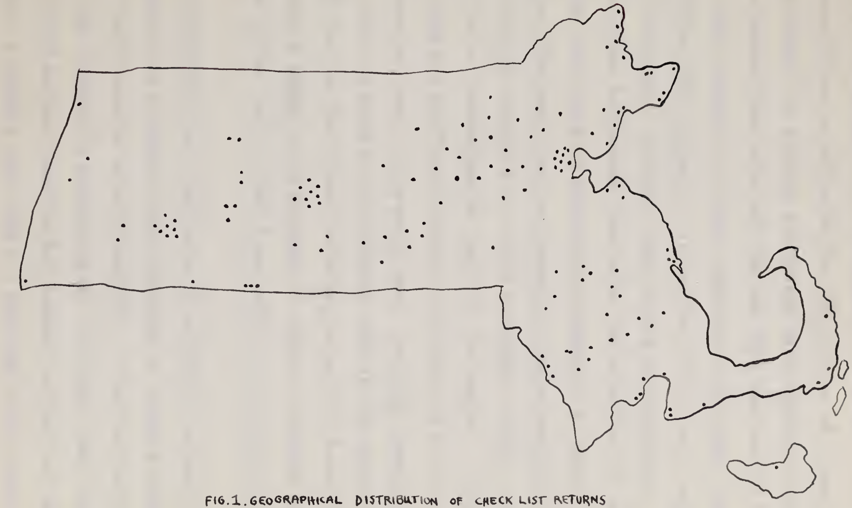


FIG. 1. GEOGRAPHICAL DISTRIBUTION OF CHECK LIST RETURNS

cerned if it measures what it attempts to measure. The questionnaire was constructed for the purpose of determining to what degree the biology classrooms were equipped with certain audio-visual aids and the use that was made of these aids. This covers, it is felt, the use of the term "status."

In the first chapter, a definition of the term "audio-visual" was given. All the items in the questionnaire conform to the definition given with the exception of such classroom facilities as electrical outlets, gas, water, space for laboratory use, and general storage room; and such classroom equipment as filing cabinets, exhibit cases or shelves and demonstration desk for the teacher. Although these items are not "audio-visual" in nature, they do affect the status and use of aids which are. For this reason the writer felt the desire for including them in the survey. Although many of the items listed may be used in departments other than biology, nevertheless, it cannot be denied that the aids listed can and have been used in the biology classrooms.

In concluding the discussion of validity, one may raise the question as to whether the sum total of schools answering the questionnaire is representative of all the public senior high schools in Massachusetts. The fact that the figures reported are based on 143 schools or 55.4 per cent and that the returns came from all sections of the state indicate an adequate sampling or a representative return.

Preparation of Tables and Graphs

In giving the results of this study in tabular and graphic form, percentages are given to the nearest tenth of a per cent. Audio-visual aids which fall into the same general classification will be treated as a group.

B. Blackboard Equipment

Table I Present status of blackboard equipment and degree to which it is used in the biology classrooms.

	On Hand	Used Often	Used Seldom	Never Used
Blackboards................	98.6	97.9	2.1	0
Colored chalk..............	80.5	63.5	34.8	1.7

Findings Table I

As may be seen from Table I, the biology classrooms are well equipped with blackboards and colored chalk and that they make extensive use of these aids.

C. Still Pictorial Materials

Heads of biology departments were requested to report on the status of these aids by indicating whether the aids were on hand, and the degree to which the aids were used. Table II is a summary of the results.

Table II Present status of still pictorial materials and degree to which they are used in the biology classrooms.

	On Hand	Used Often	Used Seldom	Used Never
Bulletin boards............	87.6	78.4	20.0	1.6
Maps......................	50.4	20.9	65.2	13.9
Graphs....................	43.4	16.1	67.8	16.1
Photographs...............	77.6	69.1	29.1	1.8
Diagrams and Posters........	83.9	80.0	20.0	0
Cartoons..................	30.8	6.8	88.1	11.4
Photos of Biologists........	45.5	17.0	79.9	3.1
Wall charts...............	78.3	89.0	11.0	0

Findings Table II

The results tabulated in Table II show that bulletin boards, diagrams and posters, and wall charts are the most available aids in that order among the still pictorial materials. Cartoons are the least available of this group in the biology classrooms.

Wall charts are the most used of these aids, with almost 90 per cent of the schools reporting making frequent use of them. Diagrams and posters, and bulletin boards came next as being used often.

D. Classroom Equipment

Table III Present status of biology classroom equipment and degree to which it is used.

	On Hand	Used Often	Used Seldom	Used Never
Filing cabinets............	53.1	64.5	28.9	6.6
Exhibit cases or shelves.....................	62.9	64.5	34.4	1.1
Demonstration desk for the teacher............	90.1	83.9	16.1	0
Bookcases with biology books for use other than regular text..........	68.5	64.3	35.7	0

Findings Table III

This table shows that among the classroom equipment the most available aid is the demonstration desk for the teacher. It is also the most often used of all these aids with over four-fifths of the schools reporting using it often.

Table IV Present status of models of the human anatomy and degree to which they are used in the biology classrooms.

	On Hand	Used Often	Used Seldom	Never Used
Human skeleton	40.0	56.7	43.3	0
Heart	18.2	57.7	42.3	0
Eye	45.5	60.0	40.0	0
Ear	31.5	54.3	45.7	0
Head	27.2	51.3	48.7	0
Torso and Head	25.2	70.4	29.6	0
Brain	9.8	50.0	48.5	1.5
Hand	7.7	45.5	51.8	2.7
Foot	3.5	40.0	40.0	20.0
Lung	3.5	20.0	60.0	20.0
Average	21.2	50.6	45.0	4.4

Findings Table IV

Among the models of the human anatomy, the most available aid is the eye but the torso and head is used more often than the others. Figure 2 gives a graphical representation of the degree to which models of the human anatomy are used in the biology classrooms. This figure makes comparisons relatively simple to illustrate and emphasize.

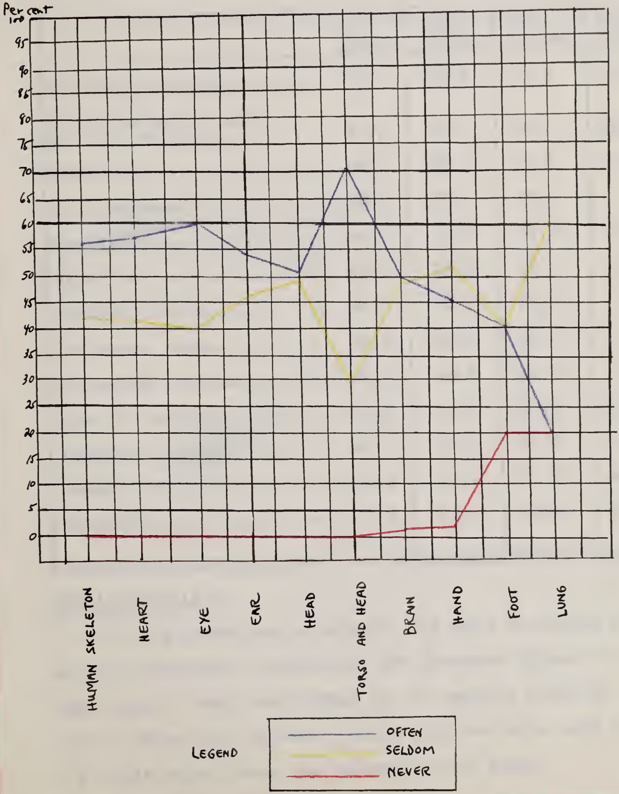


FIG. 2 DEGREE TO WHICH MODELS OF THE HUMAN ANATOMY ARE USED IN THE BIOLOGY CLASSROOMS.

[illegible]

[illegible]

E. Laboratory Equipment

Table V Present status of laboratory equipment and degree to which it is used in the biology classrooms.

	On Hand	Used Often	Used Seldom	Never Used
Laboratory manual...........	30.1	60.5	18.1	20.9
Plastic material and wood for modeling...........	30.8	22.7	31.8	45.5
Aquarium....................	60.1	55.8	40.7	3.5
Microscopes.................	88.1	70.6	29.4	0
Magnifier...................	86.0	61.0	34.9	4.1
Terrarium...................	53.1	55.3	35.5	9.2
Prepared slides.............	83.2	67.2	32.8	0
Microscope lamps............	32.2	36.9	56.6	6.5
Collecting equipment........	31.5	48.9	44.4	6.7
Cages for animals...........	30.8	40.9	38.6	20.5
Dissecting equipment........	67.1	59.4	30.2	10.4
Conservatory................	22.4	27.5	27.5	45.0
Herbarium...................	30.8	29.5	52.3	18.2

Findings Table V

Of the laboratory equipment, the most available aids are the microscope, magnifier, and prepared slides in that order. Over four-fifths of the schools reported having these aids on hand. These aids are also used to a greater extent than the others of this group.

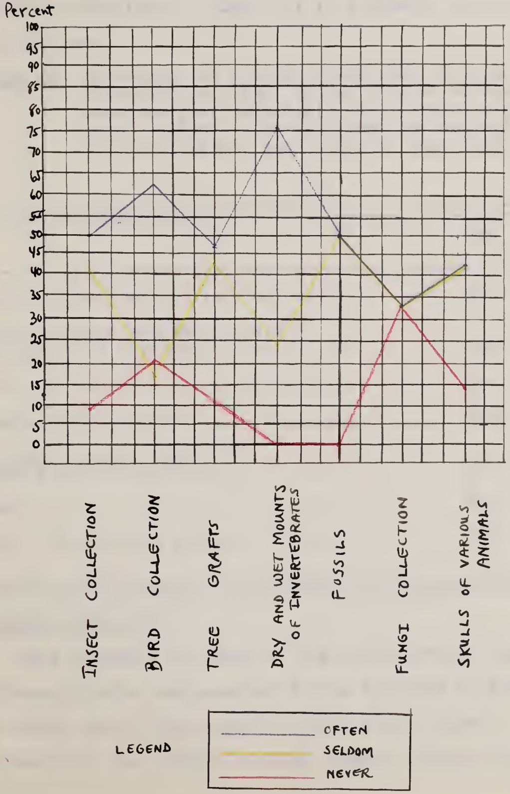
Table VI Present status of mounted specimens and degree to which they are used in the biology classrooms.

	On Hand	Used Often	Used Seldom	Used Never
Insect collection.........	49.6	50.0	40.3	9.7
Bird collection...........	20.3	62.1	17.2	20.7
Tree grafts...............	19.6	46.4	42.9	10.7
Dry and wet mounts of invertebrates..........	55.2	75.9	24.1	0
Fossils...................	4.2	50.0	50.0	0
Fungi collection..........	2.1	33.3	33.3	33.3
Skulls of various animals..................	4.9	42.9	42.9	14.3
Average...................	22.3	51.5	35.8	12.7

Findings Table VI

Dry and wet mounts of invertebrates are the most often used of the mounted specimens. Next in order are bird and insect collections. A graphic representation of the degree to which mounted specimens are used may be seen on Figure 3.

FIG.3 DEGREE TO WHICH MOUNTED SPECIMENS ARE USED IN THE BIOLOGY CLASSROOMS.



F. Classroom Facilities

Heads of the biology departments were asked to report on how well equipped their classrooms were with respect to classroom facilities. Table VII is a summary of the findings in this area.

Table VII Percentage of biology classrooms equipped with electrical outlets, motion picture screens (either stationary or portable), gas, general storage room, suitable flat-top desks for student laboratory use, water, and space for laboratory use.

	Yes	No
Electrical outlets....................	86.0	14.0
Motion picture screens, either stationary or portable................	72.0	18.0
Gas.................................	74.8	25.2
General storage room..................	60.8	39.2
Suitable flat-top desks for student laboratory use................	51.1	48.9
Water................................	83.2	16.8
Space for laboratory use..............	70.6	29.4

Findings Table VII

The biology classrooms of the public senior high schools of Massachusetts are reasonably well equipped with facilities for using audio-visual aids. Almost four-fifths of the schools have gas, motion picture screens (either stationary

or portable) and space for laboratory use. Over four-fifths of the schools reported as having electrical outlets and water. However, as many as 14.0 per cent and 16.8 per cent reported electrical outlets and water respectively as not available. This situation is not only deplorable in itself, but is a drawback to the use of other aids.

G. Projection Equipment

In the investigation of projection equipment, information was requested under five different headings: C, B, S, N, and L. The meaning of the symbols follow Table VIII which reports on the status of projection equipment. In subsequent tables the meaning of these symbols will remain the same unless otherwise stated.

Table VIII Present status of projection equipment.

	C	B	S	N	L
Micro-projector......	30.8	8.4	.7	60.1	18.2
Stereoscope..........	8.4	9.1	0	82.5	10.5
Lantern slide projector...........	30.8	23.1	6.3	39.8	11.2
Stereopticon.........	16.8	6.3	2.1	74.8	6.3
Opaque projector.....	6.3	13.9	0	89.8	8.4
Sound film projector.	35.7	36.4	3.5	24.4	11.9

C: Available in Classroom at all times.
B: Available somewhere in the same Building.
S: Available somewhere in the same school System.
N: Not available.
L: Should Like to have available.

Findings Table VIII

The majority of schools are well equipped with sound film projectors with 72.1 per cent or 103 schools out of 143 schools reporting this aid either in the biology classroom or in the same building. Table VIII shows that 39.9 per cent of the schools contacted have micro-projectors and 60.2 per cent have lantern slide projectors available to them. More than half of the schools do not have the stereopticon, stereoscope, and opaque projector available. These are also the least desired of the projection equipment. The micro-projector is the aid of this group which most schools would like available. On the whole, it appears that many schools are in need of more projection equipment.

Lantern Slides

Table IX Present status of different types of lantern slides.

Type of Slide	C	B	S	N	L
Plain glass.........	25.2	18.9	2.1	53.8	6.3
Ground glass........	16.1	6.3	2.1	75.5	2.1
Cellophane..........	5.6	2.1	0	92.3	4.2
Silhouette..........	2.1	2.8	0	95.1	2.1
Photographic........	6.3	3.5	2.1	88.1	2.1
Kodachrome..........	10.5	11.2	2.8	75.5	10.5

Findings Table IX

The plain glass type of lantern slide is more available than any other type. The kodachrome type of lantern slide is the most desired. The results of the table show that few schools have lantern slides and that few schools desire this type of aid in their biology department.

Table X Present status of sound films listed in the questionnaire.

Title	C	B	S	N	L
How We See..............	0	0	0	100	6.3
Tiny Water Animals......	0	0	.7	99.3	3.5
The Nervous System......	0	0	0	100	9.1
Respiration.............	0	0	0	100	4.2
Heart and Circulation...	1.4	.7	.7	97.2	10.5
Conservation............	0	0	0	100	2.8
Heredity................	0	0	0	100	2.1
A. B. C. D. of Heatlh...	0	.7	0	99.3	3.5
Plant Growth............	0	0	0	100	2.1
In the Beginning........	0	0	0	100	2.8
Flowers at Work.........	.7	0	0	99.3	2.8
This is T. B.	0	0	0	100	2.1
Six-Legged Saboteurs....	0	0	0	100	3.5
Birds of North America..	.7	0	0	99.3	4.2
Marine Life.............	.7	0	0	99.3	3.5
First Aid...............	0	.7	.7	98.6	1.4
Body Defenses Against Disease.................	.7	0	.7	98.6	2.8
Reproduction Among Mammals................	.7	0	.7	98.6	6.3

Findings Table X

The sound films in this table were inserted in the check list by the heads of the biology departments as those used. Table X reveals the following conclusions:

1. Only 7 schools out of 143 or 4.9 per cent have biology sound films available in the classroom at all times.
2. Only 3 schools out of 143 or 2.1 per cent have biology sound films available in the same school building.
3. Only 5 schools out of 143 or 3.5 per cent have biology sound films available in the same school system.
4. In approximately 128 schools, biology sound films are not available.

A summary of these conclusions is that few sound biology films are available in the classrooms, in the same building, and in the same school system of the public senior high schools of Massachusetts.

Table XI Present status of silent films listed in the questionnaire.

	C	B	S	N	L
How We Hear................	0	0	0	100	0
Plant Life.................	0	0	0	100	1.4
Mosquitoes.................	0	.7	0	99.3	2.8
Energy from Sunlight.......	0	0	0	100	1.4
Bacteria...................	0	.7	.7	98.6	3.5
The Living Cell............	0	.7	0	99.3	3.5
Native American Birds......	0	0	.7	99.3	.7
Ask Your Dentist...........	0	0	0	100	1.4
The Blood..................	.7	0	.7	98.6	3.5
Microscopic Animals........	0	.7	0	99.3	4.2
Seashore Animals...........	0	.7	0	99.3	3.5

Findings Table XI

Only 9 schools or 6.3 per cent have silent biology films available in the biology classrooms, in the same school building, and in the same school system of the 143 schools taking part in this tabulation.

Approximately 37 schools out of 143 desire to have this aid available. In short, very few schools have silent biology films available to them.

Table XII Present status of film strips listed in questionnaire.

Title of Film Strip	C	B	S	N	L
Louis Pasteur...............	.7	0	0	99.3	1.4
Florence Nightingale........	.7	0	0	99.3	.7
Edward L. Trudeau...........	.7	0	0	99.3	.7
Edward Jenner...............	.7	0	0	100	1.4
Walter Reed.................	.7	0	0	99.3	2.1
Hero Health Series..........	0	.7	0	99.3	2.8
Burns, Wounds, and Fractures...................	0	0	.7	99.3	2.1
Wild Flowers................	0	.7	0	99.3	2.1
Trichinosis.................	0	.7	.7	98.6	1.4
Grasshoppers................	0	0	0	100	.7
Grafting and Budding........	0	0	0	100	.7
Life Functions of the Frog..	0	0	.7	99.3	2.8

Findings Table XII

Only 10 schools out of 143 or 7 per cent have biology film strips available to them. Approximately 27 schools desire to have this type of aid available to them.

Table XIII Present status of stereographs.

	C	B	S	N	L
Stereographs	4.2	2.1	2.8	90.9	4.2

Findings Table XIII

Table XIII reveals the fact that very few schools have stereographs available in the classroom, in the same school building, and in the same school system. Only a small per cent of the schools desire to have this aid available to them.

H. Activities

Table XIV Percentage of schools making use of different activities.

	N	E	S	R	X
Biology clubs.........	50.4	18.2	2.8	.7	27.9
Planning and working on exhibits...........	30.8	35.1	21.2	7.7	5.2
Field work and trips.................	25.2	27.2	25.2	7.7	14.7
Dramatizations........	68.5	13.9	1.4	1.4	14.8
Scrapbook.............	36.4	34.3	11.2	3.5	14.6

N. No time for it at all.
E. Encouraged, but not required.
S. Sometimes required.
R. Regularly required.
X. EXtra-curricular only.

Findings Table XIV

Among those listed, field work, whether on an extra-curricular basis or on a regularly required basis, is the most common activity engaged in by the biology classrooms. Approximately 25 per cent of the schools reported having no time for it at all.

Very few schools require activities, as a group, on the regularly required basis. Dramatizations were the least engaged in of the activities with about 98 schools out of 143 reporting having no time for them at all.

1. Comments

On the questionnaire sent to the heads of the biology departments there was a section for comments. The writer hesitated to report these because he felt that they might be opinionated and subjective. However, value will be found in the study of the comments. He found them to be brief, sensible, and thought provoking.

Some of the biology department heads went overboard on their enthusiastic acceptance of audio-visual aids for the biology classroom. Others gave modified approval, accepting the tried and tested but avoiding anything radical. Finally, there was a group that virtually denied that use of audio-visual aids beyond writing on the blackboard was any good at all.

The most valuable thing about the reaction of the biology department heads was this: many teachers often operate under conditions imposed externally, beyond their better judgment and their control. On the questionnaire the biology department heads had a chance to express themselves concerning the situation under which they as teachers have to operate. Thus, we can examine the status of audio-visual aids in the classroom from the teacher's point of view.

The remarks were informal. However, as is frequently the case, a casual remark will get right at an actual

condition.

First we should like to discuss the negative votes. These comments were brief and to the point. Most of them were not dissimilar in wording or in content. The universal theme was no time on the part of the teacher and no money on the part of the school system. This was reiterated time and again. It was the most common reaction. One or two were almost shocking because of their apathy.

"Lack of time to obtain and set up projector for various periods in different rooms."

This comment seems to indicate something wrong in the biology teaching program of this school. There is inadequacy in the planning when the biology teacher is so unencumbered by teaching tools that classroom teaching periods are held for the conveniences of time and space. The writer feels that a teacher may have a fine group of audio-visual aids and still go from room to room with them. However, it is best to be established first, if possible, in a room where permanent aids may be set up.

The comment quoted also shows a common error about audio-visual aids. To many teachers a projector, motion or still, and nothing else means audio-visual aids. If they are denied this they become dispirited and lose interest in other aids which to them seem unimportant.

The following remarks demonstrate the apathy of some teachers towards using audio-visual aids:

"One teacher -- 162 pupils -- no free periods per week -- given little time."

"These are time consuming affairs. Most teachers have many jobs to do."

"Biology one period (45 minutes) every day in week. Other classes do not permit intensive work."

We cannot ignore these reactions but we can be skeptical of the skepticism and impatient with the "do-nothing" attitude expressed. A little effort and improvisation may yield audio-visual aids as good as the finest sound projector run by a professional operator showing the latest in science films.

"No funds to purchase these aids because ours is a small school."

There is never enough money to buy all school equipment. A study of the facts shows the availability of many charts, catalogues, illustrations, and even films free of charge from governmental agencies and from industrial films. Certainly there are endless ways of improvising and using ingenuity if the spirit were eager and willing and not tired.

Since most biological functions are those of motion, the use of movies in the classroom is important. The fact that they are beyond the funds of some school systems should not discourage their use. It is easy to say no time, no funds, but it is not serving progress to stop here. To advance, inertia need be overcome.

One teacher made a valuable contribution with this comment, "Field trips, I think, are as valuable as any other aid. Wish we had time for more of them."

The quantity of audio-visual aids are not so much to be emphasized as the pointedness, the aptness, and the sharpness they have to arouse interest. A student may remember, in later years, nothing of his biology studies save one field trip he took and the vivid impressions made thereon which remained with him forever. Funds are not needed for field trips. The time can be found or made. The only difficult proposition is the ingenuity, the planning, the eagerness of the teacher and his willingness to do more than the minimum.

And there was the inevitable debunking of audio-visual aids as "the softening up process that is making teaching like pre-masticated food for infants. Entertainment." Another teacher, "Interest is aroused but question the carry-over of the teacher performing the demonstration to absorption by the pupil."

We feel that if the audio-visual aid entertains to the point of awakening the interest of the pupil, this is the strongest recommendation for audio-visual aids. For what teacher does not count among his assets the ability to get the undivided interest of his class. The educative process can best function with the active cooperation of the learner and this is at its best when the pupil is aroused.

"An audio-visual aid is meaningless without the human

element of the teacher." This teacher need not fear replacement by a projector, let us say, which takes on the functions of the teacher. Unrestrained use of aids will result in mortification of the teaching process and, we think, of the learning process. The teacher must use the aid as a tool and not as a crutch. Inspiration, personality, verbal facility, good judgment, indeed, the whole human side of teaching cannot be traded for audio-visual aids and comments like the one just quoted seems to the writer superfluous, save as a warning to the teacher that use of the aids must never mean backsliding from vigorous teaching methods. Moreover, we feel that the use of aids will not usually indicate the lax teacher; more than often it is the industrious, eager, and proficient man who is keeping up with his field who knows and uses the different aids and who often has to overcome hostility to install them.

"Some information on how to use aids as well as an evaulation of the aids particularly in the film field would be most valuable."

It was comments like this that gave the writer encouragement in writing this thesis and made him feel that in a small way his work would be a contribution for those who were honestly not aware of what was being done in audio-visual aids for senior high school biology classes. Most working teachers have little of the time necessary for the developed research to find the available material.

Educational publishers or school boards might supply the biology teacher with brochures outlining what aids he could use. These would list those commercially available and suggest also many that could be improvised, obtained free, or had with little effort by the teacher. The aids, extremely useful at times in the biology classroom, are sometimes the most expensive, unfortunately. This is particularly true of films, sound and silent, movies, and slides. But even so, excellent sound projectors may be had for about $500.00 and many science films for the biology class are obtainable free on a loan basis from industrial concerns, particularly food processors, and governmental agencies.

A pamphlet, like the one suggested above, might indicate the source of supply, the minimum cost of the audio-visual aid and particularly how movies can be brought into the classroom. But beyond this, the biology teacher must have immediately at hand information that will enable him to determine what aids there are, where they can be had, their functions, and their cost. However, he should decide what aid to use for his particular teaching situation. He should be left to himself when it comes to fitting the proper aid into his own teaching setup.

"This sounds interesting and I will be interested in the results (of this paper). Our greatest difficulty is lack of storage space and improper means for darkening the room."

Most of our school buildings are not new, and their original design and construction never made allowance for some of the prerequisites of modern audio-visual aids. Some schoolrooms have improper wiring and no facilities for sound motion films, for example. Ideally we should like to have one room set aside for biology and there we could have dark curtains, a projector, slide films and whatever equipment necessary for the audio-visual aids decided upon by that biology department. The writer has been present at slide demonstrations at which students had to be posted at the window curtains to hold them back lest they belly out and let light in, and he has been at another at which the teacher pressed a button to draw light proof shades that blackened the room.

We are employing modern design in our newer homes and factories. It is equally pertinent and important that we devote this planning to our educational institutions and make allowances for the possible use of audio-visual aids in the classrooms.

CHAPTER IV

SUMMARY AND SUGGESTIONS FOR FURTHER STUDY

A. Present Status of Audio-Visual Aids

Blackboard Equipment

The biology classrooms of the public senior high schools of Massachusetts are well equipped and make extensive use of blackboards and chalk. Almost 98 per cent use blackboards and almost 64 per cent use colored chalk often. None of the schools taking part in the survey never use blackboards and only 1.7 per cent never use colored chalk.

Still Pictorial Materials

This study shows that still pictorial materials are on hand to a large degree in the biology classrooms. Of this group, wall charts are the most used with 90 per cent of the schools reporting making frequent use of them. Diagrams and posters, and bulletin boards came next as being used often. The percentage of schools that never use this type of aid ranges from only 0 per cent to 16.1 per cent.

Biology Classroom Equipment

With the exception of models of the human anatomy over 50 per cent of the biology classrooms of the schools taking part in the survey are equipped with classroom equipment. The percentages of schools which never use this type of aid in connection with the teaching of biology range from 0 per cent for bookcases (with biology books for use other

than regular text) to 6.6 per cent for filing cabinets.

Laboratory Equipment

Among the laboratory equipment, the microscope, magnifier, prepared slides, dissecting equipment, and aquarium are the most available aids in that order. Over half of the schools reported having these aids on hand. These aids are also used to a greater extent than the others of this group, namely, laboratory manual, plastic material and wood for modeling, microscope lamps, collecting equipment, cages for animals, mounted specimens, conservatory, and herbarium.

Mounted Specimens

Mounted specimens are not available to a large extent in the biology classrooms. Only a few schools reported fossils, fungi, and skulls of various animals on hand. However, where mounted specimens are available, frequent use is made of them.

Classroom Facilities

Over 50 per cent of the schools contacted are reasonably well equipped with electrical outlets, motion picture screens (either stationary or portable), gas, general storage room, suitable flat-top desks for student laboratory use, space for laboratory use, and water. However, 14.0 per cent of the schools reported electrical outlets and 16.8 per cent reported water as not available. This situation is deplorable not only in itself but is a hindrance to the

use of other aids.

Projection Equipment

The status of projection equipment in the biology classrooms could be improved. Although 72.1 per cent reported sound film projectors and 60.2 per cent reported lantern slide projectors available, less than half of the schools have the stereopticon, stereoscope, opaque projector and micro-projector available.

Projected Aids

The present status of projected aids is such that approximately 9 out of 10 schools do not have lantern slides, films, film strips and stereographs. Very few schools desire to have these type of aids available to them. This condition does not speak well for the public senior high schools of Massachusetts.

Activities

Very few schools engage in activities on a required basis. Field work is the most common activity of the biology classrooms. The other activities listed in the questionnaire, namely, biology clubs, planning and working on exhibits, dramatizations and scrapbook are used by a very few schools and on a basis other than "required." On the whole, very little is done in this area by the biology classes of the public senior high schools in Massachusetts.

Conclusion

The biology classrooms of the senior high schools of

Massachusetts are reasonably well equipped with some audio-visual aids. This is especially true in the areas of blackboard equipment, still pictorial materials, classroom equipment, laboratory equipment, and classroom facilities. In the areas of mounted specimens, projection equipment, projected aids, and activities very little is available. A summary of teacher comments such as: lack of time, lack of money, lack of information, lack of facilities, and skepticism as to the benefits to be derived indicates the reason for this state of affairs.

B. Suggestions for Further Study

The following are suggestions for further study in the field of audio-visual aids for the teaching of biology.

1. Controlled studies to determine whether any benefits are derived from the use of audio-visual aids as compared with the traditional method of instruction.

2. Studies on the relative effectiveness of different audio-visual aids in the teaching of different biological generalizations.

3. Studies of the factors which determine the extent of an audio-visual aid program in any school system.

4. A study, a number of years hence, to determine any change from this study in the status of these aids and the use that is made of them in the biology classrooms of the senior high schools of Massachusetts.

5. Service papers by educational publishers and school boards in the form of brochures or pamphlets indicating what aids are available in biology, their functions, their cost, and where they may be obtained.

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APPENDIX

Questionnaire on the Present Status of Aids to Learning being used in Biology Classrooms

Please encircle the number at the left of those aids to learning biology which you have, and place an "X" in the proper column at the right to indicate the frequency with which each is used. (where indication of frequency is appropriate.)

	Often	Seldom	Never
1. Blackboards			
2. Colored chalk			
3. Bulletin boards			
4. Maps			
5. Graphs			
6. Photographs			
7. Diagrams and Posters			
8. Cartoons			
9. Photos of Biologists			
10. Wall charts			
Please list names of charts:			
(A)			
(B)			
(C)			
(D)			
11. Filing cabinets			
12. Exhibit cases or shelves			
13. Demonstration desk for teacher			
14. Human models			
(A) Eye			
(B) Ear			
(C) Head			
(D) Torso and Head			
Please list others:			
(E)			
(F)			
(G)			
15. Bookcases with biology books for use other than regular text			
16. Human skeleton			
17. Space for laboratory use			
18. Laboratory manual			
19. Mounted specimens			
(A) Insect collection			
(B) Bird collection			
(C) Tree grafts			
(D) Dry and wet mounts of invertebrates			
Please list others:			
(E)			
(F)			
(G)			
20. Plastic material and wood for modeling			
21. Aquarium			
22. Microscopes			
23. Magnifiers			

	Often	Seldom	Never
24. Terraria			
25. Prepared slides.......			
26. Microscope lamps			
27. Collecting equipment..			
28. Cages for animals			
29. Dissecting equipment .			
30. Conservatory			
31. Herbarium (Pressed plants) ...			
Please list others:			

Please place an "X" in the appropriate column in answer to the following questions.

	Yes	No
32. Are the biology classrooms equipped with electrical outlets for projection equipment and other general use?....................		
33. Are the biology classrooms equipped with motion picture screens, either stationary or portable?		
34. Are the biology classrooms equipped with gas? .		
35. Are the biology classrooms equipped with at least one sink?		
36. Are the biology classrooms equipped with a general storage room?		
37. Are the biology classrooms equipped with suitable flat-top desks for student laboratory work?		
38. Are the biology classrooms equipped with water?		

The columns N, E, S, R, and X represent the following, respectively:

N. No time for it at all.
E. Encouraged, but not required.
S. Sometimes required.
R. Regularly required.
X. Extra-curricular only.

Please place an "X" in the appropriate column.

	N	E	S	R	X
39. Biology clubs					
40. Planning and working on biological exhibits					
41. Field work and trips					
42. Projects					
43. Dramatizations					
Please list others:					

The columns C, B, S, N, and L represent the following, respectively:

C. Available in Classroom at all times.
B. Available somewhere in the same Building
S. Available somewhere in the same School System.
N. Not available.
L. Should Like to have available.

Please place an "X" in the appropriate column or columns.

44. Micro-projector					
45. Stereoscope					
46. Lantern slide projector					
47. Lantern slides					
plain glass					
ground glass					
cellophane					
silhouette					
photographic					
Kodachrome					
48. Sound film projector					
49. Sound films					
Please list those used:					
(A)					
(B)					
(C)					
(D)					
(E)					
(F)					
50. Film strips					
Please list those used:					
(A)					
(B)					
(C)					
(D)					
(E)					
(F)					
51. Silent films					
Please list those used:					
(A)					
(B)					
(C)					
(D)					
(E)					
(F)					
52. Stereographs					
53. Stereopticon					
54. Opaque projector (Balopticon)					
Please list others:					

Your suggestions, comments, and criticisms regarding this study will be gratefully received. Please use the back of this page for this purpose.